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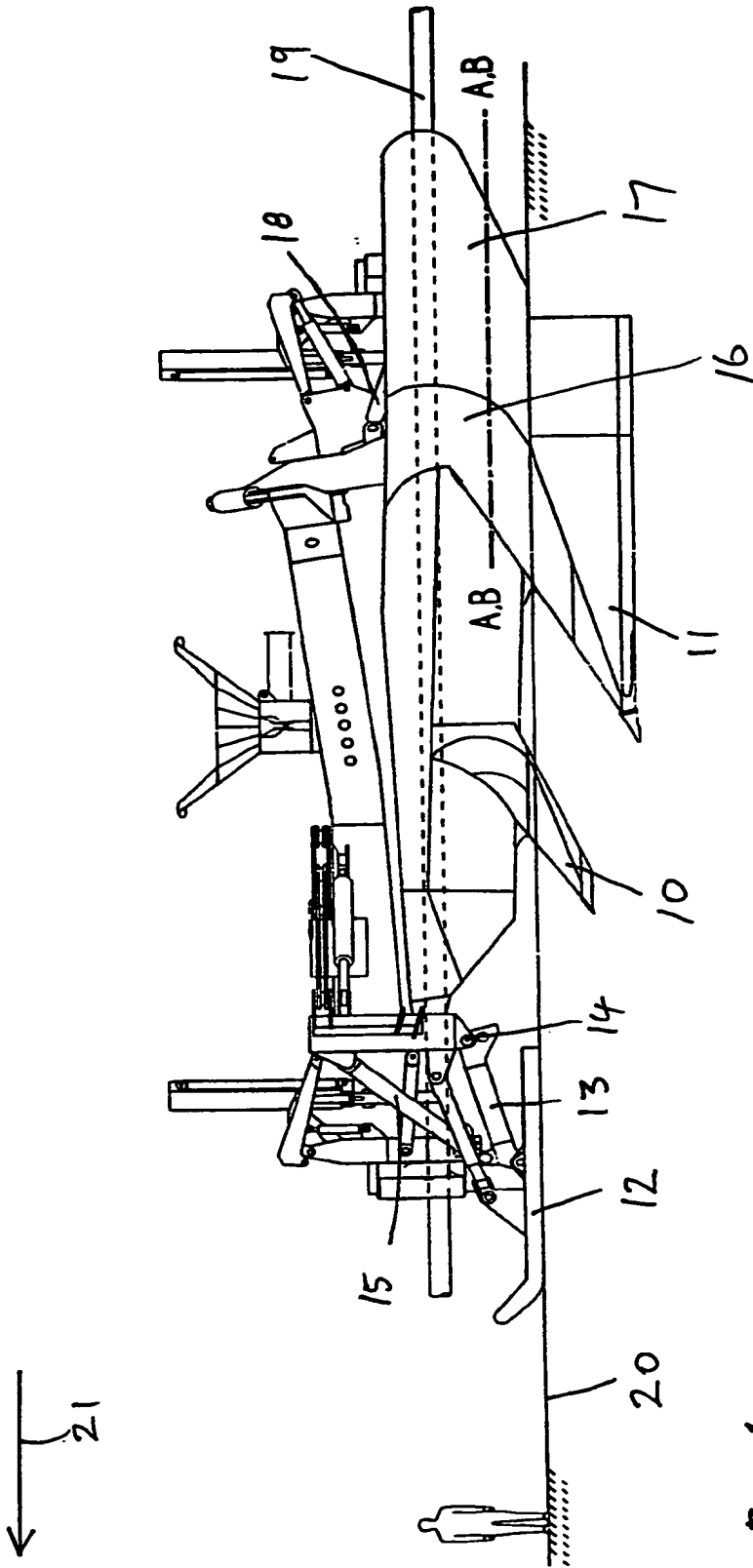


Fig. 1.

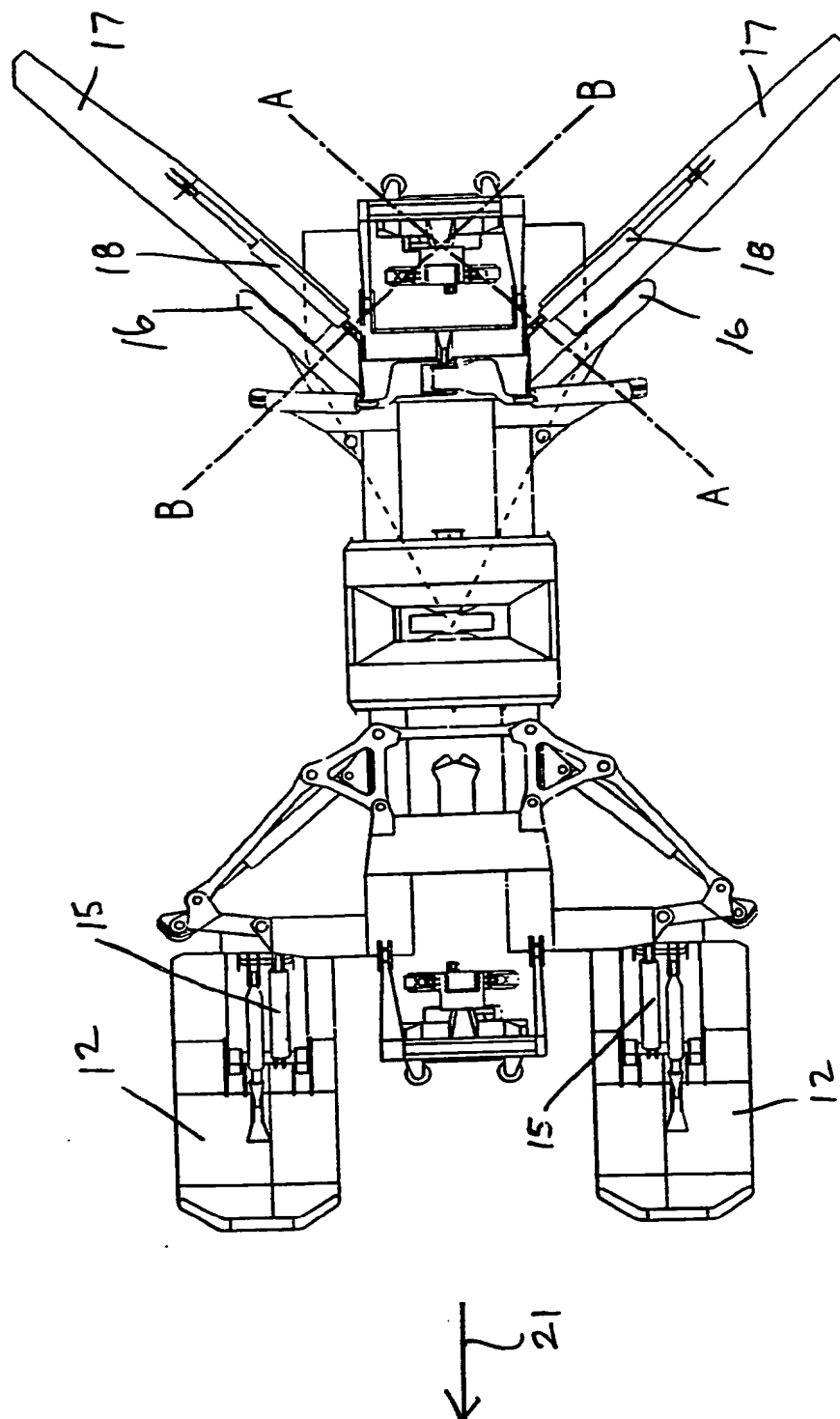


Fig. 2.

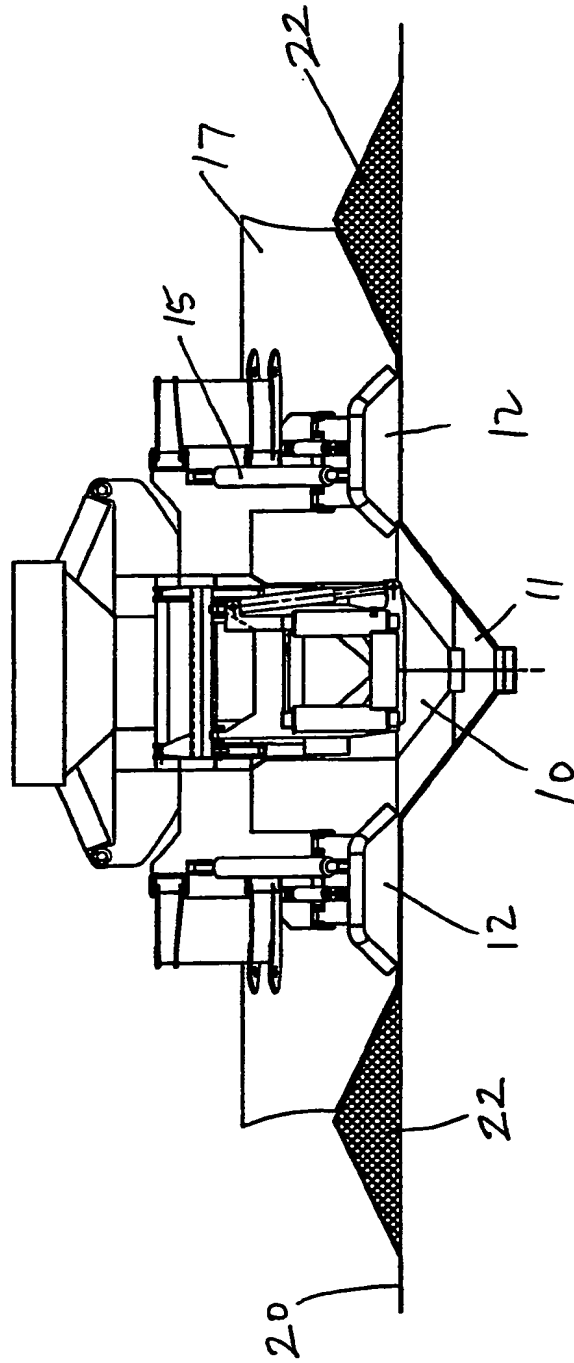


Fig. 3.

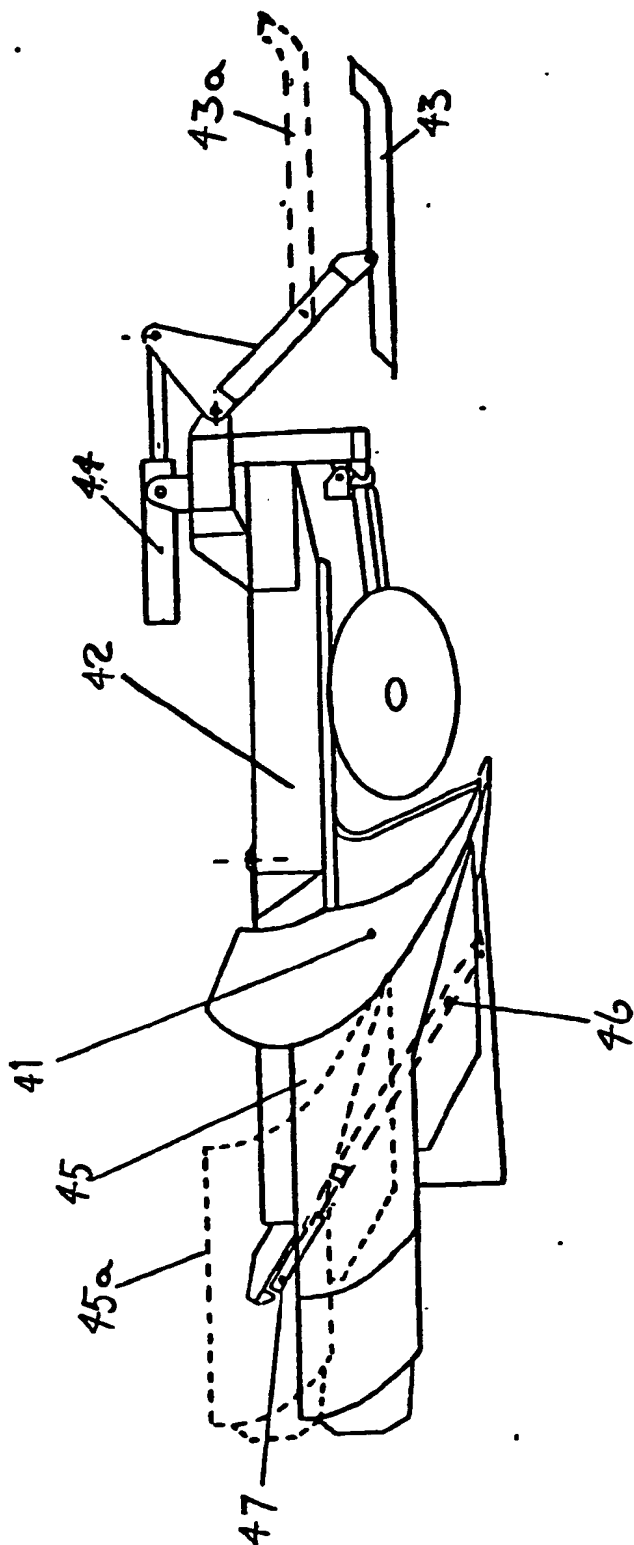


FIG. 4.

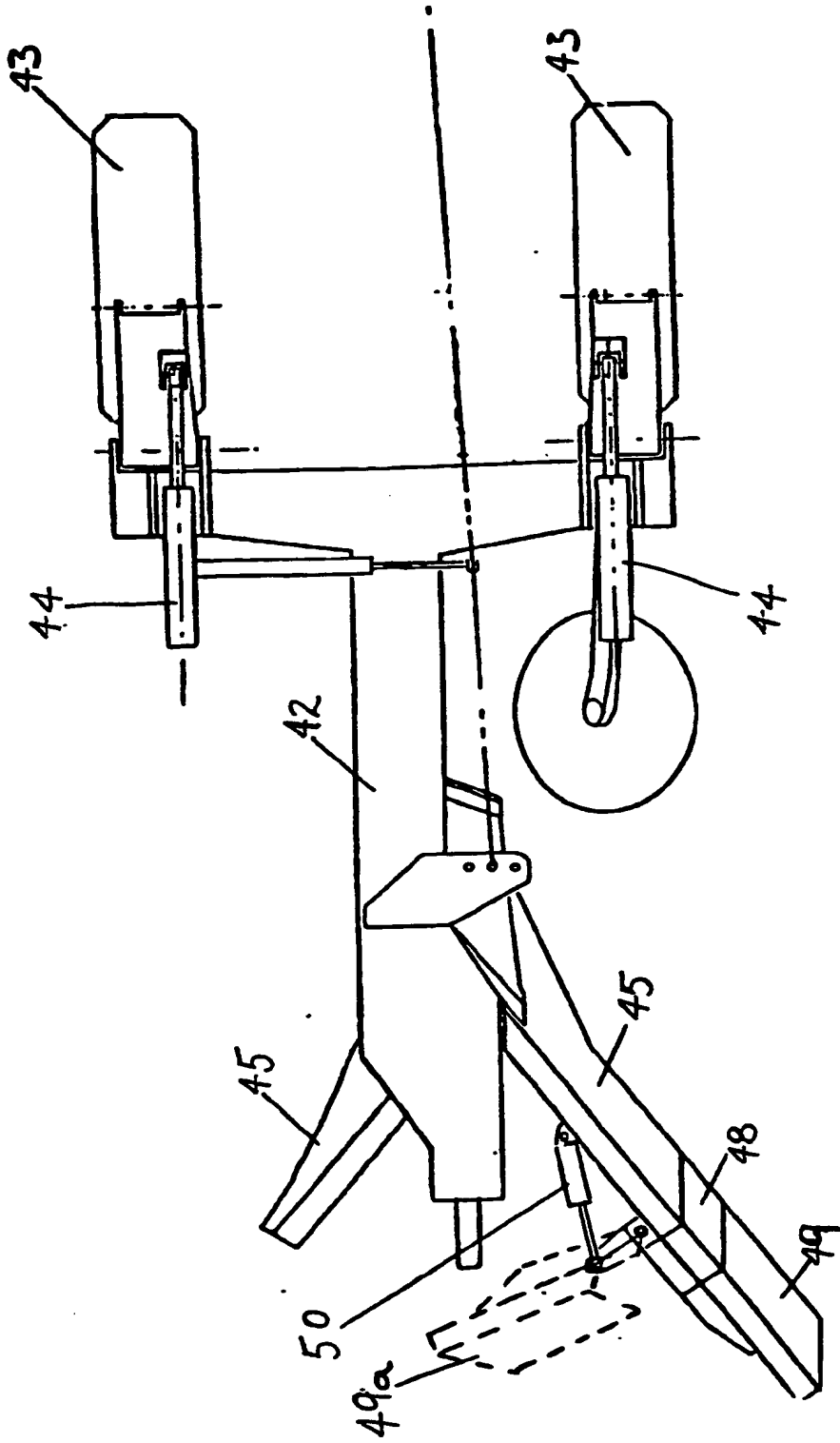
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Fig. 5.

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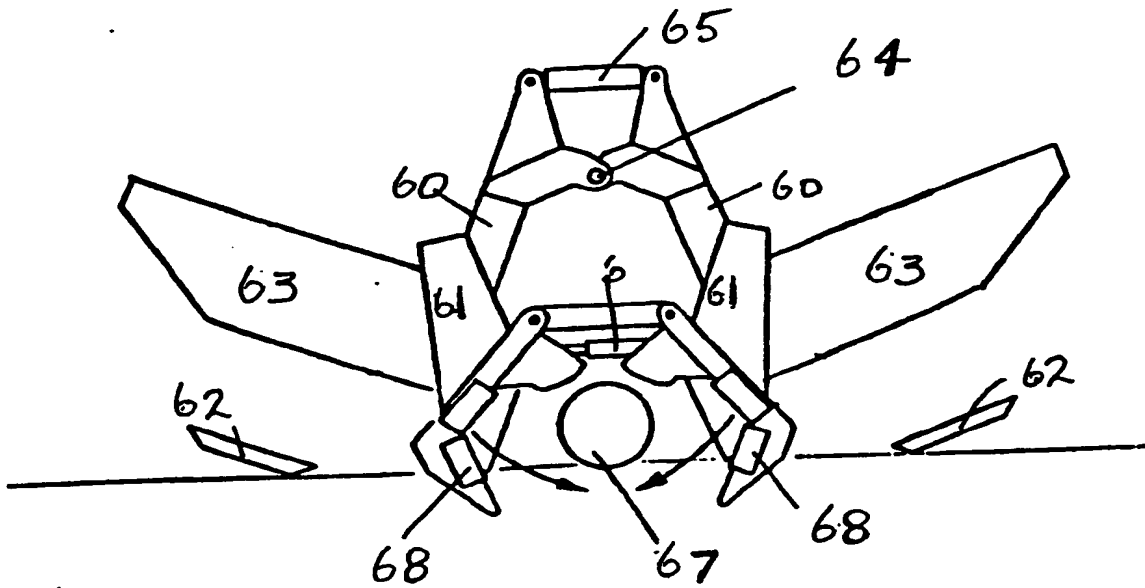


FIG. 6.

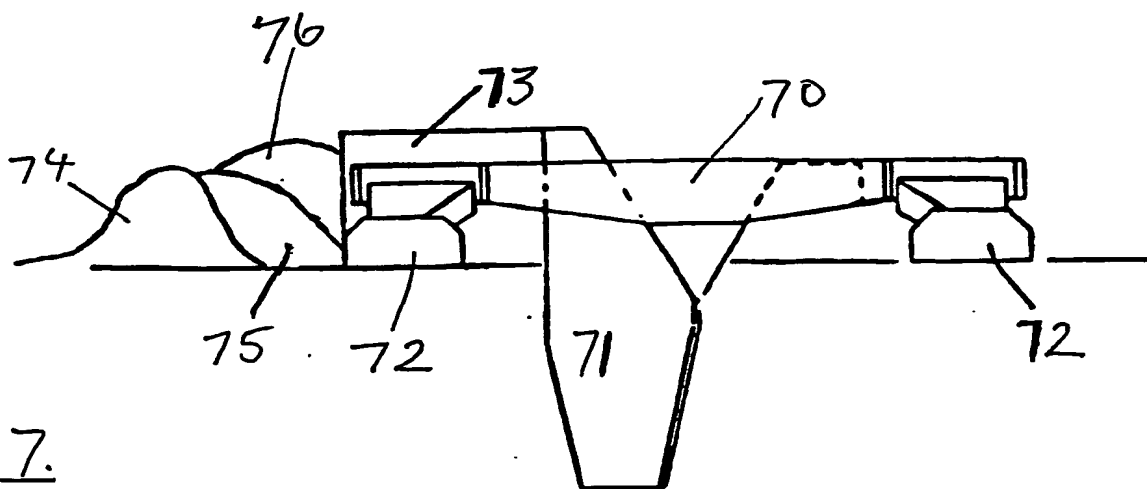


FIG. 7.

Trenching Plough

The present invention is concerned with ploughs of the type which are used for making trenches in which pipelines may be installed. It is particularly, but not exclusively, concerned with  
5 such ploughs for use in laying pipelines underwater.

When pipelines of large diameter are to be installed, it may be required to make a trench of significant depth, for example of the order  
10 of 3m. However the making of so deep a trench in a single pass of a trenching plough requires a plough of great size and weight, which in turn requires a large force to pull it through the ground. It has been suggested to use a smaller  
15 plough and to form the trench in two or more successive passes but to date that approach has proved impracticable.

It is therefore an object of the present invention to provide an improved form of trenching



plough, which is suitable for forming a trench of increasing depth in each of two or more successive passes.

5       The trenching plough according to the present invention comprises a share for cutting and lifting the soil, a ground-based share support means mounted forward of the share and adjustable relative to the share to vary the depth of cut of the share, and a mouldboard mounted rearward of the share  
10       to divert lifted soil laterally, the mouldboard also being adjustable in a generally upward direction relative to the share. By virtue of the adjustability of both the mouldboard and the share support means relative to the share, it becomes possible to  
15       cut trenches of varying depth, and in particular successive trenches of progressively increasing depth, from the same original ground surface, which may be left free of spoil excavated from the trench.

20       The trenching plough according to the present invention may comprise a single share or two or more shares and may be designed to operate asymmetrically, depositing most of the spoil to one side only of the trench, or symmetrically. An asymmetrical  
25       plough will usually be provided with a single

mouldboard and a symmetrical plough will usually have two mouldboards.

5 The ground-based share support means are preferably in the form of skids. As the skids are raised relative to the plough share or shares, so the plough cuts into the ground to a greater depth. Preferably the share support means are adjustable without raising the plough from its working location, more preferably without even  
10 halting the plough. Such adjustment may advantageously be effected hydraulically, for example by means of one or more hydraulic rams disposed between the share support means and the share or shares, or a beam or beams upon which the share  
15 or shares is/are mounted.

The or each mouldboard is so shaped and positioned as to move to the side of the trench, at ground level, spoil excavated to the ground surface by the share or shares. The mouldboard is adjustable,  
20 in a generally upward direction relative to the share, so that the mouldboard always operates at ground level. Again adjustment is preferably possible at the working location of the plough, more preferably without stopping the plough.  
25 The adjustment is preferably made hydraulically,

for example by means of one or more hydraulic  
rams. As an alternative, the mouldboard(s) may  
be attachable to the plough share(s) in two or  
more alternative attachment positions, adjustment  
5 of the mouldboard then being made by removal and  
reattachment of the mouldboard in different positions.

To enable the mouldboard to be continuously  
adjustable relative to the share, the mouldboard  
may be mounted to slide along plane inclined slides,  
10 or to move up and down about a suitably-positioned  
pivot, or upon a linkage connected directly or  
indirectly to the share.

In one preferred form of the trenching  
plough according to the invention, the or each  
15 mouldboard is of adjustable width, that is, in  
a direction transverse to the line of movement  
of the plough. This is advantageously achieved  
by providing one or more extensions to each mouldboard.  
Such extensions may simply be attachable to the  
20 mouldboard and removable as required but it is  
preferred to mount the extensions pivotally on  
the mouldboard, so that they may readily be swung  
into and out of operating position, for example  
by means of hydraulic rams, about generally vertical  
25 pivots.

The plough may be designed to divide, for example by pivoting about a generally horizontal axis, to enable a pipe to be loaded into the plough, or to enable the plough to support a pipe above the shares while the plough is in operation.

The invention will now be further described, by way of example only, with reference to the accompanying drawings, which illustrate embodiments of the trenching plough according to the present invention and wherein:-

Fig. 1 is an elevation from the side of a symmetrical plough;

Fig. 2 is a plan view of the plough of Fig. 1;

Fig. 3 is an elevation from the front of the plough of Fig. 1, showing the plough in use;

Fig. 4 is an elevation from the side of an asymmetrical second form of plough;

Fig. 5 is a plan view of the plough of Fig. 4;

Fig. 6 illustrates a symmetrical further form of plough, in an open configuration to take up a pipe; and

Fig. 7 illustrates an asymmetrical further form of plough, in the process of carrying out a third trenching pass.

5       The trenching plough illustrated in Figs. 1 to 3 comprises two shares 10, 11, set in tandem behind each other, the share 10 being somewhat smaller than, forward of and set higher than the share 11. The shares are set at a fixed height  
10 relative to the body of the plough.

      The plough body and the shares are supported upon skids 12, set forward of the share 10. The skids are mounted upon arms 13, which are pivoted at 14 to the body of the plough. By operation  
15 of hydraulic rams 15, the skids 12 may be raised or lowered relative to the plough body and in this way the depth at which the shares 10, 11 operate may be modified.

      Rearwardly of the shares 10, 11, mouldboards  
20 16, 17 are mounted upon the plough body. The mouldboards 16 are relatively smaller and are mounted in a fixed position. The mouldboards 17 are mounted about pivots and may be raised or lowered relative to the plough body by operation  
25 of hydraulic rams 18. The broken lines A-A and B-B

indicate the axes of pivoting of the mouldboards.

The plough of Figs. 1 to 3 can open up longitudinally to enable it to embrace and support a length of cable or pipeline 19 (shown in Fig. 1 only). The plough is illustrated in a typical first-pass setting, as determined by the positions of the skids 12 and mouldboards 16, 17 relative to the plough body.

When the plough is towed over the surface of the sea-bed, in the direction of the arrow 21, the shares 10, 11 cut a trench along the line of movement of the plough, the depth of the trench being controlled by the position of the shares relative to the skids 12. Soil excavated by the shares is directed outwardly from the trench by the mouldboards 16, 17 and is deposited in linear mounds 22 at the sides of the plough, beyond the outer limits of the skids.

If a deeper trench is required, or if parts of the already-excavated trench are inadequately or inaccurately excavated, for example as a result of unexpected ground conditions, the plough may be towed again along the line of the trench. A width of adequately flat sea-bed surface remains

between the trench and each mound of soil 22, upon which the skids 12 may run again. If the purpose of the second pass is to deepen the trench, then the positions of the skids and mouldboards  
5 are adjusted by rams 15 and 18 respectively before the second pass. As will be seen, each cutting pass, including any desired third or subsequent pass, will run upon the same area of sea-bed surface, still at the original level.

10 The trenching plough of Figs. 4 and 5 is asymmetrical and comprises a beam 42 to which is attached a single plough share 41. At the forward end of the beam are mounted two skids 43, the positions of which in a vertical direction  
15 relative to the share 41 are adjustable by rams 44 to determine the cutting depth of the share.

A mouldboard 45 is mounted upon the share 41 for movement up and down a slideway 46 by means of a hydraulic ram 47. Two extensions 48 and  
20 49 to the mouldboard 45 are mounted upon the mouldboard for pivoting, independently of each other, into their working positions by hydraulic rams, one of which 50 is shown in Fig. 5.

The positions of the skids 43, mouldboard  
25 45 and extension 49 in a second pass configuration

of the plough are shown in broken line at 43a, 45a and 49a respectively in Figs. 4 and 5.

When the plough is operated in its first pass configuration, the mouldboard 45, with its extensions 48 and 49, is at its maximum width and spoil raised from the trench by the share 41 is deposited by the mouldboard at the maximum distance from the trench. In the second pass configuration, the mouldboards and skids are both raised relative to the plough share 41, which cuts a deeper trench where the first trench was cut. The skids 43 run along the original ground surface, between the trench and the spoil heaps from the first pass. In this second pass operation, the mouldboard extension 49 is retracted to position 49a and spoil from the trench is deposited nearer to the trench than the first pass spoil.

In the third pass configuration, the skids and mouldboards are raised further relative to the share 41, which therefore cuts an even deeper trench. The mouldboard extension 48 is also retracted and spoil is deposited along a line inward of the two earlier spoil heaps.

An important advantage of the plough illustrated in Figs. 4 and 5 is that the skids 43 run on the



same, original ground surface in each pass, so that the depth of cut of the share is controlled throughout with the same ground surface as its reference level. In addition, because the spoil  
5 is distributed in different positions in successive passes, the excavating of the soil from the trench and its subsequent disposal laterally can be achieved with a plough of smaller overall size than would otherwise be required.

10 The plough illustrated in Fig. 6 is a symmetrical plough comprising two beams 60, 60, two shares 61, 61 supported by the beams, two depth control skids 62, 62 and two mouldboards 63, 63, all of which rotate together about a pivot 64 under control  
15 of ram 65. The plough is shown in an open configuration, in which configuration a pipe 67 can be loaded into the plough. By extending the ram 65 and retracting the ram 66, the operator may close the plough and take up the pipe 67.  
20 The plough may now carry out an excavating operation while supporting the pipe upon rollers 68, the mouldboards 63 being set at the desired height above the shares 61.

The plough of Fig. 7 is an asymmetrical plough,  
25 in which a beam 70 carries a share 71 and is supported

at its front end upon skids 72 and has a single  
mouldboard 73 mounted rearwardly of the share.  
In a first trenching pass, two lateral extensions  
of the mouldboard 73 were fully extended and spoil  
5 was deposited in the form of a linear heap 74.  
In a second pass, the outermost extension was  
retracted and a second spoil heap 75 was formed.  
Finally, in the illustrated third pass, both  
mouldboard extensions are retracted, the share  
10 71 is set at its deepest level and a third spoil  
heap 76 is deposited, generally parallel to the  
spoil heaps 74 and 75. Thus, in the three successive  
trenching passes, a successively deeper trench  
is cut, from the same seabed surface as the reference  
15 level for each excavation.

CLAIMS

1. A trenching plough comprising a share for cutting and lifting the soil, a ground-based share support means mounted forward of the share and adjustable relative to the share to vary the depth of cut of the share, and a mouldboard mounted rearward of the share to divert lifted soil laterally, the mouldboard also being adjustable in a generally upward direction relative to the share.
2. A trenching plough as claimed in Claim 1, having two or more said shares.
3. A trenching plough as claimed in either of the preceding claims, having two said mouldboards.
4. A trenching plough as claimed in any of the preceding claims, wherein the share support means are skids.
5. A trenching plough as claimed in any of the preceding claims, wherein the share support means are adjustable hydraulically.
6. A trenching plough as claimed in Claim 5, wherein the share support means are

adjustable by means of one or more hydraulic rams disposed between the share support means and the share or shares, or a beam or beams upon which the share or shares is/are mounted.

5     7.     A trenching plough as claimed in any of the preceding claims, wherein the mouldboard is mounted to slide along plane inclined slides.

8.     A trenching plough as claimed in any of Claims 1 to 6, wherein the mouldboard is mounted  
10    to move up and down upon a pivot.

9.     A trenching plough as claimed in any of Claims 1 to 6, wherein the mouldboard is mounted to move up and down upon a linkage connected to the share.

15    10.    A trenching plough as claimed in any of the preceding claims, wherein the mouldboard is adjustable hydraulically.

11.    A trenching plough as claimed in any of the preceding claims, wherein the mouldboard is  
20    of adjustable width.

12.    A trenching plough as claimed in Claim 11, wherein the mouldboard is provided with one or more extensions.

13. A trenching plough as claimed in Claim 12, wherein said extension(s) is/are attachable to the mouldboard and removable therefrom.

14. A trenching plough as claimed in Claim 5 12, wherein said extension(s) is/are mounted pivotally upon the mouldboard.

15. A trenching plough as claimed in any of the preceding claims, which is designed to divide to enable a pipe to be taken into the plough.

10 16. A trenching plough substantially as hereinbefore described with reference to, and as illustrated in, Figs. 1 to 3 of the accompanying drawings.

15 17. A trenching plough substantially as hereinbefore described with reference to, and as illustrated in, Figs. 4 and 5 or Fig 6 or Fig. 7 of the accompanying drawings.



Application No: GB 9500865.2  
Claims searched: 1 to 17

Examiner: David Pepper  
Date of search: 31 March 1995

**Patents Act 1977**  
**Search Report under Section 17**

**Databases searched:**

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.N): E1F FWB, FWDA, FWGB, FWHAL

Int Cl (Ed.6): E02F

Other: Online: WPI

**Documents considered to be relevant:**

Category	Identity of document and relevant passage	Relevant to claims
Y	EP 0452021 A (Northern Ocean Services)	2,6
X,Y	EP 0296783 A (Land & Marine Engineering) - See col 3, lines 13-35	X: 1,3-5, 8,10,15 Y: 2,6
A	US 4141667 R.J.Brown & Associates)	

X Document indicating lack of novelty or inventive step  
Y Document indicating lack of inventive step if combined with one or more other documents of same category.  
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